DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 377TH AIR BASE WING (AFMC)

Stephen P.

ENTERED

7 Nov 1997

MEMORANDUM FOR MR. STEVE PULLEN
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FROM: 377 ABW/EMR
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SUBJECT: Human Health Risk Assessment Framework - Technical Memorandum

1. We are submitting the final draft of the subject memorandum for your and Dr. Toth's review. This memorandum was developed based on the meeting conducted at Kirtland AFB on August 19, 1997, with NMED, Kirtland AFB, USACE, and contractor representatives. We would appreciate your comments by December 15, 1997.

2. Please call me at (505) 846-0053 if you have any questions and thanks for supporting this important partnering effort.

CHRISTOPHER B. DEWITT, R.P.G.
Chief, Restoration Branch
Environmental Management Division

cc:
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USACE Omaha (Mr. Rowe) w/o memo
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FRAMEWORK FOR HUMAN HEALTH RISK ASSESSMENT
A TECHNICAL MEMORANDUM
KIRTLAND AIR FORCE BASE

FINAL DRAFT

OCTOBER 1997

Prepared For
U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

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Section **Page**

ACRONYMS

AFB	Air Force Base
ARAR	applicable relevant and appropriate requirements
bgs	below ground surface
BHRA	baseline health risk assessment
CMS	corrective measure study
CSM	conceptual site model
COPC	compounds of potential concern
DOE-OB	Department of Energy - Oversight Bureau
DQO	data quality objectives
4,4-DDE	dichlorodiphenyldichloroethylene
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentrations
HEAST	Health Effects Assessment Summary Tables
INC	incomplete
IRIS	Integrated Risk Information System
LTM	long-term groundwater monitoring
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
NFA	no further action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSWMR	New Mexico Solid Waste Management Regulations
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyl
QAMS	quality assurance management staff
RCRA	Resource Conservation and Recovery Act (of 1976)
RDA	recommended daily allowance
RFI	RCRA facility investigation
RME	reasonable maximum exposure
SDWA	Safe Drinking Water Act
SNL	Sandia National Laboratories
SVOCs	semivolatile organic compounds
SWMU	solid waste management unit

EXECUTIVE SUMMARY

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted at 14 sites at Kirtland Air Force Base (AFB) to determine if contamination was released into the environment, and if so, to identify the contaminants and how large of an area is contaminated. Three of the sites were found to contain contamination above naturally occurring (background) levels and above the human health risk levels set by Region 6 of the U. S. Environmental Protection Agency (EPA). As a result, Kirtland AFB will assess the actual risk to human health at these three sites.

This document describes how Kirtland AFB plans to conduct the risk assessment. It is intended to be a plan the regulators will approve and is based on earlier discussions among Kirtland AFB, the regulators, and our contractors. The goal is to reduce the number of changes and comments, which, therefore, will result in less time and money spent on rewriting this document.

Groundwater at six of the sites is being monitored under the Long-Term Groundwater Monitoring (LTM) Program. Groundwater sample results are compared against the New Mexico Solid Waste Management Regulations (NMSWMR) Standards (20 NMAC 9.1), and, for radioactive parameters, the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs).

Table 1-1 summarizes the results of the RFI and the recommendations for each site. Further evaluation through a quantitative risk assessment is recommended for three sites where constituent concentrations exceeded background levels, namely, SWMU 6-4 (Landfills 4, 5, and 6), SWMU 6-29 (Manzano Landfill), and SWMU 6-22 (Lake Christian). SWMU 6-24 (former Manzano Sewage Treatment Facility) will not be evaluated further in the risk assessment because this site will be closed in accordance with the approved RCRA closure plan. The results of the risk assessment will be used subsequently to support the Corrective Measure Study (CMS).

Section 2 discusses the objectives of this Technical Memorandum.

Section 3 presents an overview of the Data Quality Objectives (DQO) process and the integration of the DQO framework into the baseline health risk assessment.

Section 4 describes the technical approach and methodology for estimating the baseline risks posed by the SWMUs that were proposed for further risk analysis.

Section 5 indicates the schedule for submittal of the human health risk assessment.

Table 1-1. Summary of Conclusions/Recommendations from the Phase 2 RFI (Continued)

Site	Results	Recommendation
SWMU-6-31, McCormick Ranch/Range (OT-28)	Beryllium and manganese were detected above the EPA screening levels in two soil samples each. One sample also exceeded the DOE-OB background concentration for beryllium, but was below the background UTL. Neither sample exceeded the background UTL for manganese. Constituents in groundwater were below NMSWMR health-based standards. Gross beta radioactivity in two wells has exceeded the SDWA MCL.	NFA; residential use. Continued monitoring under LTM Program.
SWMU 6-22, Lake Christian (OT-46)	Soil and sediment samples did not contain constituents above EPA screening levels. Groundwater has contained fluoride, iron, manganese and sulfate above NMSWMR health-based or aesthetic groundwater standards. Gross alpha and gross beta radioactivity have also been detected above the SDWA MCLs.	Industrial use. Further evaluate using risk assessment during the CMS. Continued monitoring under LTM Program.
SWMU 6-16, Kirtland AFB Fire Training Area (FT-13)	Beryllium was detected above the EPA screening level in three soil samples, but none exceeded the DOE-OB background concentration. Constituents in groundwater did not exceed NMSWMR health-based standards.	NFA; industrial use. Continued monitoring under LTM Program.
SWMU 6-24, Manzano Sewage Treatment Facility (WP-16)	One pesticide, 4,4-DDE, and two metals, beryllium and manganese, were detected above EPA screening levels in soil samples. Of the four samples containing beryllium above the EPA screening level, one also exceeded the DOE-OB background concentration and the background UTL. Of the two samples with manganese above the EPA screening level, one also exceeded the background UTL.	Industrial use. Complete RCRA closure in accordance with approved closure plan; further evaluate using risk assessment during the CMS.
Appendix II Sites		
SWMU 6-3, Landfill 3 (LF-07)	Beryllium was detected above the EPA screening level in three soil samples, one of which also exceeded the DOE-OB background concentration and the background UTL.	NFA; industrial use.
SWMU 6-8, Landfill B (LF-15)	Beryllium was detected above the EPA screening level in one soil samples, but was below the DOE-OB background concentration.	NFA; industrial use; possible cover system to eliminate ponding, minimize erosion, and control runoff.

2. OBJECTIVES

This technical memorandum (TM) describes the parameters and decision criteria applied in the performance of the baseline health risk assessment (BHRA) intended to support the CMS for Kirtland AFB. The objective of this TM is to obtain a regulatory consensus on the parameters that will be applied in the BHRA. The concept of developing a technical memorandum for risk assessment was originally defined in the Office of Solid Waste and Emergency Response (OSWER) Directive 9835.15a (EPA, 1991). By establishing a consensus prior to implementation of the risk assessment, a defensible risk evaluation is completed with a reduced number of iterations.

Step 2 (identify the decision) defines the decision or action that will be implemented to solve the stated problem in Step 1. For these SWMUs at Kirtland AFB, the baseline health risks will be one of the criteria for the decision of "no further action" or "corrective action" at the site.

Step 3 (identify the inputs to the decision) establishes the data or information required to support the decision formulated in Step 2. The data requirements are the components of the BHRA which include the list of COPCs, the exposure assessment, the toxicity assessment, and the risk characterization.

Step 4 (define the boundaries of the study) of the DQO process defines the spatial boundaries of the study. In the risk assessment, the study boundaries refer to the exposure boundaries. The exposure boundaries determine the sample points that will be included in calculating the chemical concentrations in each environmental medium at the point of exposure (i.e., exposure point concentration). For each site at Kirtland AFB, the study boundaries for the human health risk assessment will be the physical site boundaries. Section 4 presents a discussion of the methodology for calculating the chemical intake of each receptor based on the concentrations at the points of exposure.

Step 5 of the DQO process (develop a decision rule) defines the conditions that would cause the risk manager to choose among the alternative actions identified in Step 2. The statistical parameter is a descriptive measure (i.e., average, maximum, 95% upper confidence limit [UCL]) that specifies the exposure point concentration. Another decision rule that may be specified is the acceptable level of numerical risk that would support the decision in Step 2.

Step 6 (specify limits on decision errors) of the DQO process refers to the risk manager's acceptable decision error rate based on a consideration of the consequences of making an incorrect decision. The uncertainties inherent in a risk assessment will be discussed in the evaluation of the results of the risk characterizations.

Step 7 (optimize the design) identifies the most effective and valid methodology for performing the baseline risk assessment. A deterministic risk assessment will be conducted in order to be consistent with the conservative approach being undertaken at Kirtland AFB.

4.1.1 SWMU 6-4, Landfills 4,5, and 6 (LF-08)

Landfills 4, 5, and 6 are located contiguous to one another in the northwest portion of Kirtland AFB. They are bounded by the Tijeras Arroyo to the north, a drainage berm to the south, Powerline Road (unpaved) to the west, and, to the east (about 150 feet east of Powerline Road), a covered slope of the recently closed general refuse portion of the active construction and demolition debris landfill. A Decision Document to finish Landfill 6 was completed and signed in 1994. The Decision Document reported EPA's approval to combine Landfill 6 with Landfills 4 and 5. Originally, they were listed as two separate SWMUs.

The site, not including the recently closed general refuse landfill or the construction and demolition debris landfill, has an area of approximately 76 acres and is protected from surface drainage by an earthen dike system. A 6-foot thick, non-RCRA native soil cap was constructed at this site in 1992 to comply with state regulations. The cap has been graded recently and is only sparsely vegetated. The original fill depth was estimated to be 2 ft deep on the north and south edges and 40 ft deep near an east-west centerline. The surface area and total volume of fill were estimated to be 30 acres and 600,000 cubic yards, respectively. The landfill can be divided into three areas, based on periods of use:

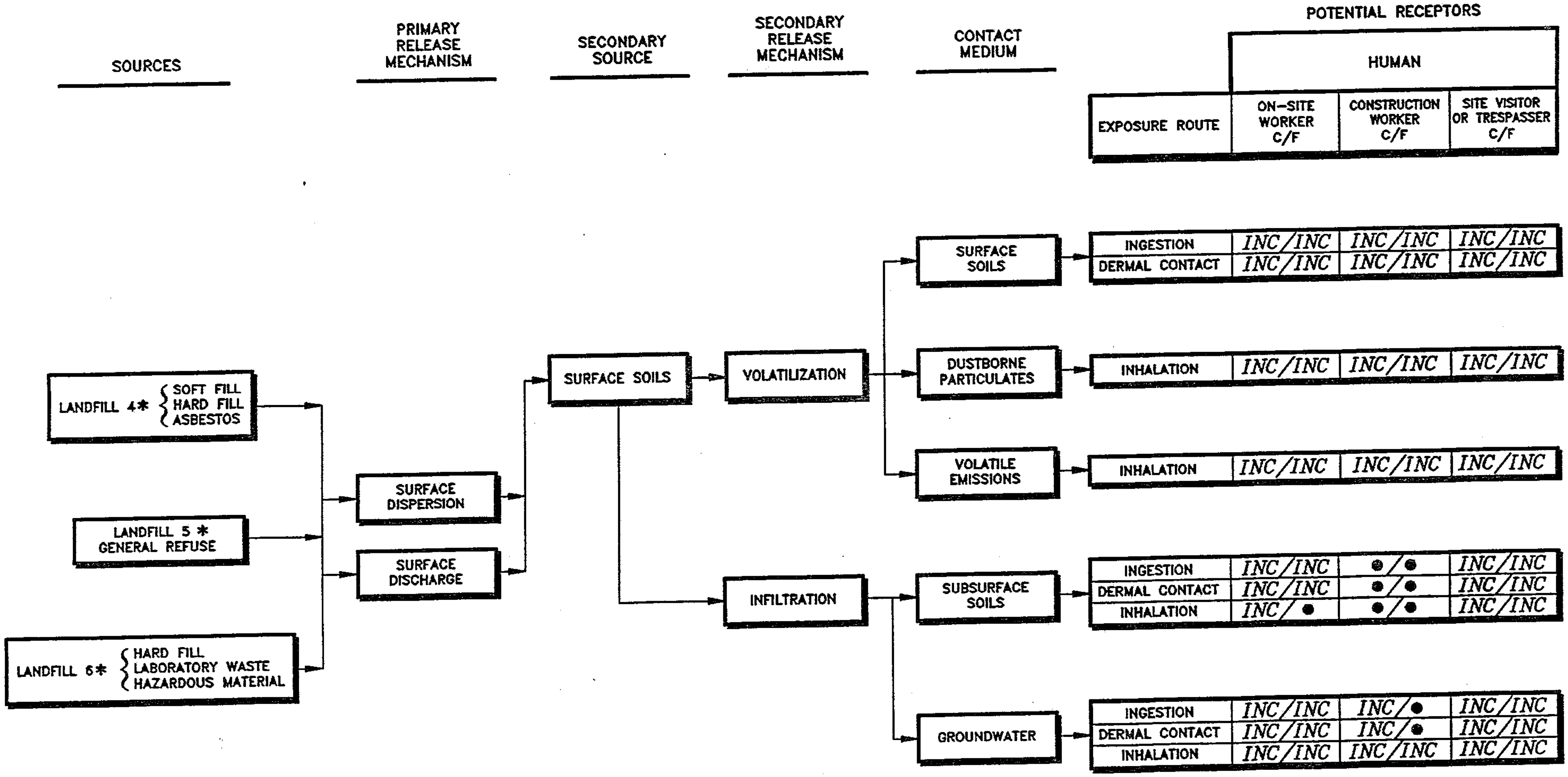
- The western portion of the site (Landfill 5), which covers an area of approximately 26 acres, was operated jointly by the City of Albuquerque and Kirtland AFB from 1960 to 1989. The now-abandoned landfill served as a general refuse disposal site for the base. Wastes were not inspected before they were placed in the landfill, and they were placed in unlined trenches. There are no records of the types of waste disposed.

- The eastern portion (Landfill 4) was operated from 1980 to 1994. This portion occupies an area of approximately 22 acres, including a soft-fill area (commercial, residential, yard/landscape, and agricultural refuse), a hard-fill area (construction and demolition debris), and an asbestos disposal area. Records from 1991 to 1994 exist for the asbestos landfill. Wastes were disposed in unlined cells using the area-fill method. No hazardous or liquid wastes are known to have been disposed in Landfill 4.

- Landfill 6 consisted of approximately 28 acres and was used for disposal of construction debris from 1989 through 1994. Prior to 1989, laboratory waste (such as carcasses of laboratory animals and rubber gloves) and possibly hazardous materials were reportedly disposed of in Landfill 6.

Metals were the primary constituents detected among the soil samples that were collected and analyzed. Beryllium and manganese were found at concentrations above screening levels in several of the 55 soil samples collected at this site. Most of the concentrations of these metals are below background levels for Kirtland AFB. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), chlorinated herbicides, and organochlorine pesticides/polychlorinated biphenyls (PCBs) were detected in soil samples. Of these, none exceeded EPA screening levels except for several SVOCs in the 40-foot sample from one borehole (designated F from the Phase 2 RFI).

The six groundwater monitoring wells at this site are monitored under the LTM program, as well as a program designed for compliance with NMSWMR. Additional monitoring wells will be installed at this site during the CMS to complete definition of perched groundwater. Other than water quality parameters, metals were the only constituents detected in the groundwater samples. VOCs and SVOCs were not detected above reporting limits in groundwater samples. Acetone and bis(2-ethylhexyl)phthalate were attributed to laboratory contamination.



C = CURRENT PATHWAY
F = FUTURE PATHWAY
INC = INCOMPLETE
● = COMPLETE
** = SOURCE AREA HAS 6 FT. THICK, NON-RCRA CAP (SINCE 1992).*

FIGURE 4-1 CONCEPTUAL SITE MODEL – SWMU 6-4, LANDFILLS 4, 5, AND 6 (LF-08)

At some time prior to 1959, a portion of the site was covered with sandy soil to an unknown thickness. A softball field was constructed on the northern portion of the site, where 1956 air photos show a water-filled depression or excavation.

4.1.2.1 Geology/Hydrogeology

Manzano Landfill overlies the uppermost Santa Fe Group west of the Tijeras Fault Zone and may directly overlie the Sandia Fault. The area east of the Sandia Fault typically is characterized by unconsolidated sediment deposits of relatively shallow depth overlying granitic bedrock of the Manzanita Mountains. The area west of the Sandia Fault typically is characterized by thick (up to 15,000 ft), unconsolidated alluvial deposits of the Santa Fe Group overlying a downthrown granitic fault block. The heterogeneous deposits of the Santa Fe Group consist of unconsolidated and semi-consolidated sands, gravels, silts, and clays.

There are no monitoring wells at Manzano Landfill and depth to groundwater is unknown. As previously mentioned, groundwater was not encountered during the drilling of boreholes to approximately 100 feet. In the area of Manzano Landfill, saturated zone hydrology is characterized by a flow system complicated by the juxtaposition of different stratigraphic units across one or more faults. In addition, the faults themselves probably have a significant influence on groundwater flow. The hydrogeology east of the faults is poorly understood but regional groundwater elevation contour maps indicate that groundwater flows generally to the west.

4.1.2.2 Conceptual Site Model

Figure 4-2 is a CSM developed for SWMU 6-29 based on information collected during the RFI.

Sources of Potential Release - Samples collected during the RFI activities defined the nature and extent of contamination at SWMU 6-29. Additional surface soil characterization and installation of two groundwater monitoring wells will be performed as part of the CMS to support the risk assessment for this site. Potential sources of release at the LF-20 consist of fire-training areas, disposal and open burning areas for general refuse. The landfill was covered prior to 1959.

Potential Release Mechanisms - The primary release mechanism may be through surface spills to surface soil and surface dispersion. However, since the landfill was covered with sandy soil of unknown thickness, there is no potential direct contact with chemicals in the surface soil. No VOCs were detected, hence, there would not be a chemical transport through volatilization. Infiltration/percolation could eventually transport the constituents from the shallow subsurface soil to greater depths. The RFI stated that groundwater was not encountered to a depth of 100 feet, therefore, the ability of soil constituents to migrate vertically will rely on the soil characteristics, the chemical fate and transport properties, and climate data at the site. The results of the predictive modeling will indicate whether future exposures to groundwater will be evaluated in the baseline risk assessment.

Potential Exposure Routes - Based on the land use, the CSM identifies the different routes through which a receptor may come in contact with COPCs in the environmental media. Potential exposure routes under both current and future land use were identified and evaluated. Closed circles in Figure 4-2 indicate the complete exposure routes; "INC" indicates incomplete exposure routes.

The landfill area currently has a softball field and future land use of SWMU 6-29 is industrial. Therefore, the potential current and future exposures may be through the following pathways:

- Incidental ingestion and dermal contact with subsurface soil, and
- Inhalation of dustborne particulates from subsurface soils.

There is no complete exposure through inhalation of volatile emissions from soil because no VOCs were detected. Because sandy soil on the surface is of unknown thickness, an impact from sub-surface soil is possible through the pathways listed above. Potential exposures to groundwater cannot be evaluated because, as previously mentioned, there are no monitoring wells at the Manzano Landfill and groundwater was not encountered to a depth of 100 feet.

Potential Receptors - The human receptors (both current and future) who may be potentially exposed to constituents in the environmental media are the onsite worker, the onsite construction worker, and the site visitor/recreational user.

4.1.3 SWMU 6-22, (Lake Christian), OT-46

Lake Christian is a manmade lake located in the southeastern portion of Kirtland AFB. The lake is approximately 200 feet x 100 feet and 40 feet deep and is surrounded by foliage. The lake was constructed in the 1960s for use as an underwater explosives testing facility and was used until the mid-1970s to study the effects of underwater detonation of explosives such as trinitrotoluene (TNT) and pentolite. The land surface in the vicinity of Lake Christian slopes to the west and an open drainage ditch is located less than 250 feet north of the site.

Soil samples, groundwater samples, surface water samples, and bottom-sediment samples have been collected from Lake Christian and characterization is considered complete. During the Phase II, Stage 2A RFI, beryllium was detected in all six of the samples above the proposed Subpart S action level, but all concentrations were below the USGS calculated background value (USAF, 1993). VOCs were not detected in any of the soil samples. No soil samples were collected during the Phase 2 RFI. Five lake bottom sediment samples were collected during the Phase II, Stage 2A RFI, and four lake bottom sediments were collected during the Phase 2 RFI. Beryllium was detected in four of the five Phase II, Stage 2A RFI lake bottom sediments above the proposed Subpart S action level, but below the USGS calculated background value. VOCs detected in these samples were below the screening criteria. Metals in Phase 2 RFI sediment samples were below screening criteria.

Groundwater samples were initially collected from monitoring wells located west (KAFB-1901, -1903) and east (KAFB-1902) of Lake Christian. Between May and December 1996, no pesticides, herbicides, phenols, total organic halogens (TOX), or coliform were detected in any of the wells. Detected metals included iron, manganese, and sodium. Other inorganics detected include chloride, fluoride, nitrate, sulfate, and total organic carbon (TOC). Gross alpha and gross beta radioactivity were detected above SDWA MCLs. An additional groundwater monitoring well (KAFB-1904) was installed due south of Lake Christian during the Phase 2 RFI. Groundwater samples collected from this well did not contain detectable concentrations of pesticides or explosives. Nitrate and metals concentrations were below the screening criteria. Wells KAFB-1902, -1903, and -1904 continue to be monitored under the LTM Program.

4.1.3.1 Geology/Hydrogeology

Lake Christian is located east of the Hubble Springs Fault and overlies the Santa Fe Group, which is characterized by unconsolidated alluvial fill overlying Permian siltstones and Pennsylvanian fractured limestone bedrock. The vadose zone on the east side of the fault ranges from 50 to 150 feet thick and is composed primarily of alluvial fan material. A production well located approximately 1,600 feet southwest of Lake Christian was used to control the water level in the lake.

4.1.3.2 *Conceptual Site Model*

Figure 4-3 is the CSM developed for SWMU 6-22 based on the information collected during the RFI.

Sources of Potential Release - Samples collected during the RFI activities defined the nature and extent of contamination at SWMU 6-22. Potential sources of release at OT-46 consist of detonated explosives in the lake.

Potential Release Mechanisms - The primary release mechanism may be through partitioning or dispersion of the constituents in the surface water to the sediments at the bottom of the lake. Constituents at the bottom of the lake may eventually infiltrate and migrate to the groundwater downgradient from the site.

Potential Exposure Routes - Based on the land use, the CSM identifies the different routes through which a receptor may come in contact with COPCs in the environmental media. Potential exposure routes under both current and future land use were identified and evaluated. Closed circles in Figure 4-3 indicate the complete exposure routes; "INC" indicates the incomplete exposure routes.

Lake Christian is a fenced area that is not accessible by site visitors or trespassers. Therefore, these receptors will not be evaluated for potential contact with the sediments in the lake. Future plans for SWMU 6-22 include draining the water from the lake and fill the depression with clean soil so that the area can be redeveloped for industrial operations. Therefore, the potential current and future exposures may be the following:

- Current exposures of any onsite worker through incidental ingestion and dermal contact with the surface waters and sediment,
- Future exposures of the construction worker through incidental ingestion and dermal contact with surface water and sediment while engaged in activities such as draining the lake or redeveloping the area, and
- Incidental ingestion and dermal contact with groundwater.

A small population of fish was introduced into the lake and is being maintained by site personnel. No recreational fishing occurs at the lake, hence, there is no exposure through ingestion of fish that may have contacted constituents in the surface water and/or sediments in the lake.

Potential Receptors - Under the current land use, the human receptors who may be potentially exposed to constituents detected in Lake Christian are the onsite workers, the site visitor, and the construction worker who would be involved in draining the lake and in other activities associated with the redevelopment of the area.

4.2 Step 2: Identify the Decision

There are two possible decisions that can be reached after the baseline risks are defined. The decisions and their associated actions are listed below:

Decision 1:	If baseline risks do not exceed the acceptable level of risk, no further action will be proposed.
Decision 2:	If baseline risks exceed the acceptable level of risk, corrective action will be proposed.

considered incomplete at SWMU 6-29. There is no indirect exposure through inhalation of volatile emission from groundwater because no volatiles were detected above reporting limits. Potential contact with surface water and sediments at SWMU 6-22 (Lake Christian) will also be evaluated.

The current and future receptors who will be evaluated in the risk assessment include the site worker, recreational user/site visitor, and construction worker.

4.3.4 Input 4: Exposure Parameters

A matrix of exposure parameters for the site worker, recreational user/trespasser, and construction worker is presented in Table 4-1. The exposure parameters are either EPA Region 6 standard default assumptions or are site-specific parameters based on information collected from Kirtland AFB. Standard EPA risk assessment references will be consulted for dermal absorption factors, volatilization factors, and particulate emission factors.

4.3.5 Input 5: Algorithms for Calculating Exposure Dose

The algorithms for calculating the intake through ingestion, dermal contact, and inhalation are presented below.

Ingestion Algorithm

$$Ingestion\ Dose_a = \frac{Cs\ x\ IR\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AP}$$

where: AP = averaging period (days) (AT_c for carcinogens; AT_{nc} for noncarcinogens)
BW = body weight (kg)
CF = unit conversion factor (10^{-6} kg/mg)
Cs = chemical concentration in soil (mg/kg)
ED = exposure duration (years)
EF = exposure frequency (days/year)
Ingestion $Dose_a$ = adult ingestion dose (mg/kg-day)
IR = ingestion rate (mg/day)

Inhalation Algorithm. For inhalation exposure to soils, the soil-to-air volatilization factor and the particulate emission factor were calculated according to equations presented in EPA's Technical Background Document for Soil Screening Guidance (EPA, 1994b). The inhalation algorithms are as follows:

$$Inhalation\ Dose_a = \frac{C_s\ x\ InhR\ x\ ET\ x\ EF\ x\ ED \left(\frac{1}{VF} + \frac{1}{PEF} \right)}{BW\ x\ AP}$$

where: AP = averaging period (days) (AT_c for carcinogens; AT_{nc} for noncarcinogens)
BW = body weight (kg)
C_S = constituent concentration in soil (mg/kg)
ED = exposure duration (years)

EF	=	exposure frequency (days/year)
ET	=	exposure time (hours/day)
Inhalation Dose$_a$	=	adult inhalation dose (mg/kg-day)
InhR	=	inhalation rate (m^3/hr)
PEF	=	particulate emission factor (m^3/kg); site-specific value
VF	=	volatilization factor (m^3/kg); chemical-specific

Dermal Algorithm. The algorithm for calculating the intake through dermal contact is the following:

$$Dermal\ Dose_a = \frac{Cs\ x\ SSA\ x\ ABS\ x\ SAR\ x\ EF\ x\ ED\ x\ CF}{BW\ x\ AP}$$

where:

ABS	=	absorption fraction of chemical from soil (unitless)
AP	=	averaging period (days) (AT_c for carcinogens; AT_{nc} for noncarcinogens)
BW	=	body weight (kg)
CF	=	unit conversion (10^{-6} kg/mg)
C_S	=	chemical concentration in soil (mg/kg)
Dermal Dose$_a$	=	adult dermal dose (mg/kg-day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
SAR	=	soil adherence rate (mg/cm^2)
SSA	=	skin surface area exposed (cm^2/day)

4.3.6 Input 6: Toxicity Assessment

The toxicity assessment examines information concerning the potential human health effects of exposure to the chemicals of potential concern. Its goal is to provide, for each listed COPC, a basis for the risk characterization.

The cancer slope factor (SF) is the toxicity value used to quantitatively express the carcinogenic risk of cancer-causing constituents. The slope factor is expressed in units of $(mg/kg/day)^{-1}$. The RfD is the toxicity value used to quantitatively express the hazard of noncarcinogenic constituents and is expressed in units of mg/kg/day.

The primary sources of toxicity values are the EPA Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1994c). If there are constituents with no available toxicity values, the NMED will be consulted.

4.4 Step 4: Define the Boundaries of the Study

The exposure unit defines the spatial extent of exposure that a receptor may have to a specific chemical. Surface soil exposures will be limited to samples collected at depths from 0 through 6 inches below ground surface (bgs) whereas subsurface soil exposures will be limited to samples collected from 6 inches through 15 feet bgs. The onsite worker and recreational user are considered to be exposed only to surface soil whereas the construction worker is considered to have exposures to both surface and subsurface soils.

Climate data and site-specific geology, lithology, and other soil parameters (i.e, moisture content, porosity) will be presented to demonstrate that fate and transport modeling is/is not warranted to